

Oblique Corrections in the MSSM at One Loop. II. Fermions

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Abstract

This paper is the completion of an earlier work which involves the derivation of oblique corrections in the MSSM at one-loop. In terms of the two-component spinor formalism, which is new in compared with those used in the literature, the contributions arising from the fermion superpartners i.e, neutralino-chargino sector to self-energy of standard model electroweak gauge bosons are calculated. Corresponding descendants the S , T and U parameters are presented. The validity of our results is examined in two ways, which are then followed by detailed analysis on the results in the literature.

1 Introduction

As more data collected at the LHC, more hints imply the absence of natural supersymmetry (SUSY) as the TeV-scale new physics beyond standard model (SM). It seems possible to establish or rule out the minimal supersymmetric model by combining the present data at the LHC and other colliders.

One way to explore this issue is by analyzing the oblique corrections [1, 2] to electroweak observables arising from the supersymmetric particles. The logic is that these new states contribute to the precise electroweak observables such as the weak mixing angle s_W^2 , whose values depend on these new states' masses. What is interesting is that the sensitivity to these masses (including the SM-like Higgs mass) in MSSM is quite unlike to the situation in SM [3], where the dependence on m_h is logarithmic. On the other hand, more robust bounds on superpartners masses appear at the LHC in comparison with the other high energy colliders. To date the uncertainties for these observables can more severely constrain the allowed region for these superpartners masses than what we have expected before.

In this paper, we complete our calculations of the oblique corrections in MSSM based on our previous work [3]. We follow the two-component spinor formalism [4] to calculate the self-energy diagrams of vector bosons with neutralino and chargino-fermions loop. This formalism is very useful since the charginos χ_i^\pm are Dirac, while the neutralinos χ_j^0 are Majorana fermions. Although more graphs need to be considered compared with the four-component spinor formalism, it is quite straightforward to evaluate these graphs by incorporating one-loop integral functions [5].

The paper is organized as follows. In section 2, we briefly review the Lagrangian for the neutralino-chargino (NC) sector. we emphasize the notation and conventions when necessary. In section 3, we derive the contributions in the NC sector. To examine the results presented in section 3, section 4 is devoted to a preliminary check via the decoupling limit. In section 5, we derive the S , T , U parameters relevant to the corrections to precise electroweak observables. The property of finiteness for these parameters can serve as another examination on the validity of the results. Finally, we compare our results and those proposed in the literature, and make a few comments and conclusions. An appendix is added to explicitly show the relevant Feynman rules in the NC sector for our calculations.

2 Lagrangian For the NC Sector

As completion we begin with a brief review on the Lagrangian for NC sector, address the notations and conventions when necessary. The Lagrangian for NC sector under gauge eigenstates is given by,

$$\begin{aligned}
\mathcal{L} = & -i\tilde{W}^{\dagger a}\bar{\sigma}^{\mu}(\delta^{ac}\vec{\partial}_{\mu} + g\epsilon^{abc}W_{\mu}^b)\tilde{W}^c \\
& - i((\tilde{H}_{\mu}^+)^{\dagger}, (\tilde{H}_{\mu}^0)^{\dagger})\bar{\sigma}^{\mu}(\vec{\partial}_{\mu} - ig'B_{\mu} - igY_1W_{\mu}^a\tau^a) \begin{pmatrix} \tilde{H}_{\mu}^+ \\ \tilde{H}_{\mu}^0 \end{pmatrix} \\
& - i((\tilde{H}_d^0)^{\dagger}, (\tilde{H}_d^-)^{\dagger})\bar{\sigma}^{\mu}(\vec{\partial}_{\mu} - ig'B_{\mu} - igY_2W_{\mu}^a\tau^a) \begin{pmatrix} \tilde{H}_d^0 \\ \tilde{H}_d^- \end{pmatrix}
\end{aligned} \tag{1}$$

Where W^a represent the $SU(2)_L$ gauge symmetry, Y_1 and Y_2 label the $U(1)_Y$ charges for the Higgs doublets. Reorganize the freedoms in (1) and adopt the convention for charginos and neutralinos,

$$\begin{pmatrix} \tilde{C}_1^+ \\ \tilde{C}_2^+ \end{pmatrix} = V \begin{pmatrix} \tilde{W}_1^+ \\ \tilde{H}_{\mu}^+ \end{pmatrix}, \quad \begin{pmatrix} \tilde{C}_1^- \\ \tilde{C}_2^- \end{pmatrix} = U \begin{pmatrix} \tilde{W}_1^- \\ \tilde{H}_d^- \end{pmatrix} \tag{2}$$

as well as $\psi^T = (\tilde{B}^0, \tilde{W}^0, \tilde{H}_d^0, \tilde{H}_{\mu}^0)$, (1) can be rewritten as,

$$\begin{aligned}
\mathcal{L} = & \left[-e\delta_{ij}(\tilde{C}_i^+)^{\dagger}\bar{\sigma}^{\mu}\tilde{C}_j^+ + e\delta_{ij}(\tilde{C}_i^-)^{\dagger}\bar{\sigma}^{\mu}\tilde{C}_j^- \right] A_{\mu} \\
& + \frac{g}{c} \left[O_{ij}^L(\tilde{C}_i^+)^{\dagger}\bar{\sigma}^{\mu}\tilde{C}_j^+ - O_{ij}^R(\tilde{C}_i^-)^{\dagger}\bar{\sigma}^{\mu}\tilde{C}_j^- + O_{ij}^{\prime L}(\tilde{N}_i^0)^{\dagger}\bar{\sigma}^{\mu}\tilde{N}_j^0 \right] Z_{\mu} \\
& + g \left[O_{ij}^L(\tilde{N}_i^0)^{\dagger}\bar{\sigma}^{\mu}\tilde{C}_j^+ - O_{ij}^R(\tilde{N}_i^0)^{\dagger}\bar{\sigma}^{\mu}(\tilde{C}_j^-)^{\dagger} \right] W_{\mu}^- + c.c
\end{aligned} \tag{3}$$

with the definitions involved with the matrixes in (3),

$$\begin{aligned}
O_{ij}^L &= -\frac{1}{\sqrt{2}}N_{i4}V_{j2}^* + N_{i2}V_{j1}^* \\
O_{ij}^R &= -\frac{1}{\sqrt{2}}N_{i3}^*U_{j2} + N_{i2}^*U_{j1} \\
O_{ij}^{\prime L} &= -V_{i1}V_{j1}^* - \frac{1}{2}V_{i2}V_{j2}^* + \delta_{ij}s_W^2 \\
O_{ij}^{\prime R} &= -U_{i1}U_{j1}^* - \frac{1}{2}U_{i2}U_{j2}^* + \delta_{ij}s_W^2 \\
O_{ij}^{\prime\prime L} &= -O_{ij}^{\prime\prime R} = \frac{1}{2}(N_{i4}N_{j4}^* - N_{i3}N_{j3}^*)
\end{aligned} \tag{4}$$

The Lagrangian (3) gives rise to the relevant Feynman rules for the NC sector, which are explicitly presented in the appendix A. We can find that they agree with those shown in Fig. K.2.1 and Fig. K.2.2 in [4].

3 One-loop Contributions

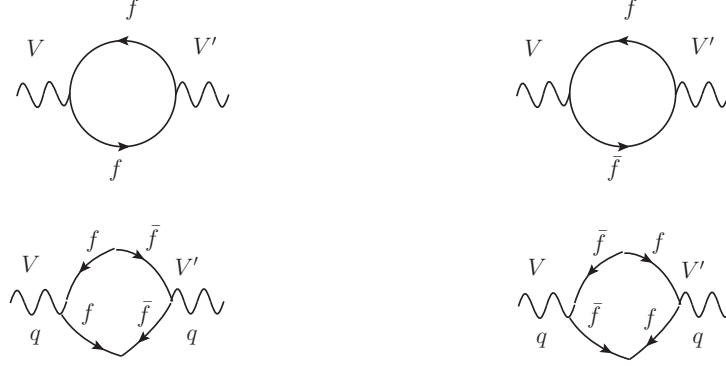


Figure 1: Graphs that contribute to the self-energy of SM γ and Z bosons in the neutralino-chargino sector.

In terms of the Feynman rules for neutral vector fields A_μ and Z_μ coupled to the neutralinos and charginos shown in the appendix A, we see that the fermion pair in the fermion loop in fig.1 is either composed of $(\tilde{C}_i^\pm, \tilde{C}_j^\pm)$ or $(\tilde{N}_i^0, \tilde{N}_j^0)$. In particular, only the neutral fermion pair in the fermion loop contributes to the self-energy of Z boson, as in comparison with the self-energy of γ . There are four Feynman diagrams for $i\Pi^{\gamma\gamma}$, four Feynman diagrams for $i\Pi^{\gamma Z}$ and six diagrams for $i\Pi^{ZZ}$ in this sector. Explicitly, these graphs give us ¹,

$$\Pi^{\gamma\gamma}(q^2) = 4e^2[2A(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) - a(m_{\tilde{C}_i^+}^2) + 2q^2 b_0(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2)] \quad (5)$$

$$\Pi^{\gamma Z}(q^2) = \frac{eg}{c}(O_{ii}^L + O_{ii}^R) \left[-4A(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) + 2a(m_{\tilde{C}_i^+}^2) - q^2 b_0(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) \right] \quad (6)$$

and

$$\begin{aligned} \Pi^{ZZ}(q^2) = & \frac{g^2}{c^2} \left[(O_{ij}^L O_{ji}^L + O_{ij}^R O_{ji}^R) \left(4A(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) - a(m_{\tilde{C}_i^+}^2) - a(m_{\tilde{C}_j^+}^2) \right) \right. \\ & + \left(q^2 - m_{\tilde{C}_i^+}^2 - m_{\tilde{C}_j^+}^2 \right) b_0(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \\ & + O_{ij}^{\prime L} O_{ji}^{\prime L} \left(4A(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) - a(m_{\tilde{N}_i^0}^2) - a(m_{\tilde{N}_j^0}^2) \right) \\ & + \left. \left(q^2 - m_{\tilde{N}_i^0}^2 - m_{\tilde{N}_j^0}^2 \right) b_0(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \right] \\ & + \frac{2g^2}{c^2} \left[2O_{ij}^L O_{ji}^R m_{\tilde{C}_i^+} m_{\tilde{C}_j^+} b_0(q^2; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) - O_{ij}^{\prime L} O_{ji}^{\prime L} m_{\tilde{N}_i^0} m_{\tilde{N}_j^0} b_0(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \right] \end{aligned} \quad (7)$$

¹Note that there is an one-loop factor $16\pi^2$ multiplied by the $\Pi^{VV'}$ ignored throughout this section.

For the definition of functions $A(q^2; x, y)$, $a(x)$ and $b_0(q^2; x, y)$, we refer the reader to see appendix B in [3].

According to the property that W bosons only couple to χ_i^0 and χ_i^\pm , not their anti-fermions, there is only one type of Feynman diagram as shown in fig. 2, with $(\tilde{C}_i^\pm, \tilde{N}_j^0)$ in the fermionic loop. There are total four graphs needed to be evaluated in this situation. Using the Feynman rules shown in the appendix A yields

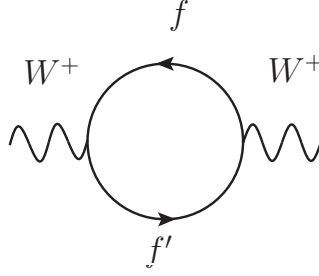


Figure 2: Graph that contributes to the self-energy of W boson the neutralino-chargino sector.

$$\begin{aligned}
\Pi^{WW}(q^2) &= g^2 \left[((O_{ij}^L)^* O_{ij}^L + (O_{ij}^R)^* O_{ij}^R) \left(4A(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) - a(m_{\tilde{N}_i^0}^2) - a(m_{\tilde{C}_j^+}^2) \right) \right. \\
&\quad \left. + \left(q^2 - m_{\tilde{N}_i^0}^2 - m_{\tilde{C}_j^+}^2 \right) b_0(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \right] \\
&\quad + 2g^2 \left[(O_{ij}^L)^* O_{ij}^R m_{\tilde{N}_i^0} m_{\tilde{C}_j^+} b_0(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) + (O_{ij}^R)^* O_{ij}^L m_{\tilde{N}_i^0} m_{\tilde{C}_j^+} b_0(q^2; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \right]
\end{aligned} \tag{8}$$

4 A Preliminary Check via Decoupling Limit

Now we proceed to perform a fast check on the results presented in the previous section. Since the matrixes O 's appearing in (5) to (8) used to diagonalize the mass matrixes of neutralino $\mathcal{M}_{\tilde{N}}$ and $\mathcal{M}_{\tilde{C}}$ are the main sources for the complication, we take the large superpartner mass, i.e, the decoupling limit from the SM, to simplify these matrixes.

From the decoupling limit in which $M_{1,2} \gg v_{\mu,d}$ and $\mu \gg v_{\mu,d}$, we obtain [7],

$$O^L = O^R = \begin{pmatrix} 0 & 0 \\ 1 & 0 \\ 0 & -\frac{i}{2} \\ 0 & \frac{1}{2} \end{pmatrix}, \quad O'^L = O'^R = \begin{pmatrix} s^2 - 1 & 0 \\ 0 & s^2 - \frac{1}{2} \end{pmatrix} \tag{9}$$

and

$$O''^L = O''^R = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{i}{2} \\ 0 & 0 & \frac{i}{2} & 0 \end{pmatrix} \quad (10)$$

Substituting (5) to (8), (9) and (10) into the difference between the two definitions of weak mixing angle squared s^2 and s_*^2 results in,

$$\begin{aligned} s^2 - s_*^2 &\equiv -\frac{c^2}{m_W^2} [\Pi^{WW}(m_W^2) - c^2 \Pi^{ZZ}(m_Z^2)] + \frac{sc^3}{m_W^2} \Pi^{\gamma Z}(m_Z^2) \\ &= \left[2(m_{\tilde{N}_2^0} - m_{\tilde{C}_1^+})^2 + \frac{1}{2}(m_{\tilde{N}_3^0} - m_{\tilde{C}_2^+})^2 + \frac{1}{2}(m_{\tilde{N}_4^0} - m_{\tilde{C}_2^+})^2 - \frac{1}{2}(m_{\tilde{N}_3^0} - m_{\tilde{N}_4^0})^2 \right] \eta + \dots \end{aligned} \quad (11)$$

In (11), we have ignored the finite terms. By using the fact that $m_{\tilde{C}_2^+} = m_{\tilde{N}_3^0} = m_{\tilde{N}_4^0} = \mu$ and $m_{\tilde{C}_1^+} = m_{\tilde{N}_2^0} = M_2$ (M_2 denotes the second gaugino mass) under the decoupling limit, we arrive at the conclusion that the divergent parts in (11) cancel exactly.

How about the finite property of (11) on general grounds? The answer to this question is unclear due to the complication that the matrixes as coefficients in the results (5) to (8) are tied to the gaugino masses $M_{1,2}$ and μ term. Without the information about these soft masses, one can not determine them generally.

5 Estimates of S , T , U Parameters

In this section, we derive the NC sector's contribution to parameters S , T and U [1, 2], which measure the oblique corrections to precise electroweak observables. The dependence of S , T and U parameters on $\Pi^{IJ}(p^2)$ is given by [1, 2],

$$\begin{aligned} S &\equiv -\frac{16\pi}{e^2} sc \left[sc \Pi^{\gamma\gamma'}(0) - sc \Pi^{ZZ'}(0) + (c^2 - s^2) \Pi^{\gamma Z'}(0) \right] \\ T &\equiv \frac{4\pi}{e^2} \left[\frac{\Pi^{WW}(0)}{m_W^2} - \frac{\Pi^{ZZ}(0)}{m_Z^2} - \frac{2s}{c} \frac{\Pi^{\gamma Z}(0)}{m_Z^2} \right] \\ U &\equiv \frac{16\pi s^2}{e^2} \left[\Pi^{WW'}(0) - c^2 \Pi^{ZZ'}(0) - s^2 \Pi^{\gamma\gamma'}(0) - 2cs \Pi^{\gamma Z'}(0) \right] \end{aligned} \quad (12)$$

with $\Pi^{IJ'}(0) = d^2 \Pi^{IJ} / dp^2 |_{p^2=0}$, here Π^{IJ} represents the part with metric as the coefficient in $\Pi_{\mu\nu}^{IJ} = g_{\mu\nu} \Pi^{IJ} + \dots$.

Substitute (5) to (8) into (12) gives rise to ²,

$$\begin{aligned}
\pi S_{NC} = & -s^2 c^2 \left(8A'(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) + 2b_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \right) \\
& + (O_{ij}^L O_{ji}^L + O_{ij}^R O_{ji}^R) \left[4A'(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) + b_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \right. \\
& - \left. \left(m_{\tilde{C}_i^+}^2 + m_{\tilde{C}_j^+}^2 \right) b'_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \right] + 4O_{ij}^L O_{ji}^R m_{\tilde{C}_i^+} m_{\tilde{C}_j^+} b'_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \\
& - 2O_{ij}^{\prime\prime L} O_{ji}^{\prime\prime L} m_{\tilde{N}_i^0} m_{\tilde{N}_j^0} b'_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) + O_{ij}^{\prime\prime L} O_{ji}^L \left[4A'(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \right. \\
& + \left. b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) - \left(m_{\tilde{C}_i^+}^2 + m_{\tilde{C}_j^+}^2 \right) b'_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \right] \\
& + (c^2 - s^2) (O_{ii}^L + O_{ii}^R) \left(4A'(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) + b_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) \right) \quad (13)
\end{aligned}$$

$$\begin{aligned}
\pi T_{NC} = & \frac{1}{4s^2 m_W^2} \left[((O_{ij}^L)^* O_{ij}^L + (O_{ij}^R)^* O_{ij}^R) \left(4A(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) - a(m_{\tilde{N}_i^0}^2) - a(m_{\tilde{C}_j^+}^2) \right) \right. \\
& - \left. \left(m_{\tilde{N}_i^0}^2 + m_{\tilde{C}_j^+}^2 \right) b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \right] + 2 \left((O_{ij}^L)^* O_{ij}^R + (O_{ij}^R)^* O_{ij}^L \right) m_{\tilde{N}_i^0} m_{\tilde{C}_j^+} b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \\
& - (O_{ij}^L O_{ji}^L + O_{ij}^R O_{ji}^R) \left(4A(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) - a(m_{\tilde{C}_i^+}^2) - a(m_{\tilde{C}_j^+}^2) \right) \\
& - \left(m_{\tilde{C}_i^+}^2 + m_{\tilde{C}_j^+}^2 \right) b_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) - 4O_{ij}^L O_{ji}^R m_{\tilde{N}_i^0} m_{\tilde{C}_j^+} b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \\
& - O_{ij}^{\prime\prime L} O_{ji}^{\prime\prime L} \left(4A(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) - a(m_{\tilde{N}_i^0}^2) - a(m_{\tilde{N}_j^0}^2) - \left(m_{\tilde{N}_i^0}^2 + m_{\tilde{N}_j^0}^2 \right) b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \right) \\
& + 2s^2 (O_{ii}^L + O_{ii}^R) \left(4A(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) - 2a(m_{\tilde{C}_i^+}^2) \right) + 2O_{ij}^{\prime\prime L} O_{ji}^{\prime\prime L} m_{\tilde{N}_i^0} m_{\tilde{N}_j^0} b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \quad (14)
\end{aligned}$$

and

$$\begin{aligned}
\pi U_{NC} = & [(O_{ij}^L)^* O_{ij}^L + (O_{ij}^R)^* O_{ij}^R] \left[4A'(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) - \left(m_{\tilde{N}_i^0}^2 + m_{\tilde{C}_j^+}^2 \right) b'_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \right. \\
& + \left. b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \right] + 2 [(O_{ij}^L)^* O_{ij}^R + (O_{ij}^R)^* O_{ij}^L] m_{\tilde{N}_i^0} m_{\tilde{C}_j^+} b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) \\
& - O_{ij}^{\prime\prime L} O_{ji}^{\prime\prime L} \left[4A'(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) + b_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{C}_j^+}^2) - \left(m_{\tilde{N}_i^0}^2 + m_{\tilde{N}_j^0}^2 \right) b'_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \right] \\
& - [O_{ij}^L O_{ji}^L + O_{ij}^R O_{ji}^R] \left[4A'(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) - \left(m_{\tilde{C}_i^+}^2 + m_{\tilde{C}_j^+}^2 \right) b'_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \right. \\
& + \left. b_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) \right] + 2s^2 (O_{ii}^L + O_{ii}^R - s^2) \left(4A'(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) + b_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_i^+}^2) \right) \\
& - 4O_{ij}^L O_{ji}^R m_{\tilde{C}_i^+} m_{\tilde{C}_j^+} b'_0(0; m_{\tilde{C}_i^+}^2, m_{\tilde{C}_j^+}^2) + 2O_{ij}^{\prime\prime L} O_{ji}^{\prime\prime L} m_{\tilde{N}_i^0} m_{\tilde{N}_j^0} b'_0(0; m_{\tilde{N}_i^0}^2, m_{\tilde{N}_j^0}^2) \quad (15)
\end{aligned}$$

From (13) to (15) one can see that the finite property of parameters S , T and U is obvious.

If we assume that the SUSY mass splitting between any two mass parameters in the set

²Note that the summation over index i and j is performed throughout (13) to (15).

of $m_{\tilde{N}_i}$ and $m_{\tilde{C}_j}$ is small compared with themselves, the results in (13) to (15) can be further simplified as,

$$\pi S_{NC} \simeq \frac{1}{3} \left[\ln \frac{m_{\tilde{N}_3^0}^2}{m_{\tilde{C}_2^+}^2} + \frac{m_{\tilde{N}_4^0}^2 - m_{\tilde{N}_3^0}^2}{2m_{\tilde{N}_4^0}^2} \right] \quad (16)$$

$$\begin{aligned} \pi T_{NC} \simeq & \frac{1}{16s^2 m_W^2} \left[-4 \left(\frac{m_{\tilde{C}_1^+}^2 - m_{\tilde{N}_2^0}^2}{m_{\tilde{C}_1^+}^2} \right)^2 m_{\tilde{N}_2^0}^2 \left(\frac{1}{2} \ln \frac{m_{\tilde{N}_2^0}^2}{\Lambda^2} + \frac{1}{3} \right) \right. \\ & - \left(\frac{m_{\tilde{C}_2^+}^2 - m_{\tilde{N}_3^0}^2}{m_{\tilde{C}_2^+}^2} \right)^2 m_{\tilde{N}_3^0}^2 \left(\frac{1}{2} \ln \frac{m_{\tilde{N}_3^0}^2}{\Lambda^2} + \frac{1}{3} \right) \\ & \left. - \left(\frac{m_{\tilde{C}_2^+}^2 - m_{\tilde{N}_4^0}^2}{m_{\tilde{C}_2^+}^2} \right)^2 m_{\tilde{N}_4^0}^2 \left(\frac{1}{2} \ln \frac{m_{\tilde{N}_4^0}^2}{\Lambda^2} + \frac{1}{3} \right) + \left(\frac{m_{\tilde{N}_4^0}^2 - m_{\tilde{N}_3^0}^2}{m_{\tilde{N}_4^0}^2} \right)^2 m_{\tilde{N}_3^0}^2 \left(\frac{1}{2} \ln \frac{m_{\tilde{N}_3^0}^2}{\Lambda^2} + \frac{1}{3} \right) \right] \end{aligned} \quad (17)$$

together with

$$\begin{aligned} \pi U_{NC} \simeq & \frac{1}{6} \left[8 \ln \frac{m_{\tilde{N}_2^0}^2}{m_{\tilde{C}_1^+}^2} + 2 \ln \frac{m_{\tilde{N}_4^0}^2}{m_{\tilde{C}_2^+}^2} + 4 \frac{m_{\tilde{C}_1^+}^2 - m_{\tilde{N}_2^0}^2}{2m_{\tilde{C}_1^+}^2} \right. \\ & \left. + \frac{m_{\tilde{C}_2^+}^2 - m_{\tilde{N}_4^0}^2}{m_{\tilde{C}_2^+}^2} + \frac{m_{\tilde{C}_2^+}^2 - m_{\tilde{N}_3^0}^2}{m_{\tilde{C}_2^+}^2} - \frac{m_{\tilde{N}_4^0}^2 - m_{\tilde{N}_3^0}^2}{m_{\tilde{N}_4^+}^2} \right] \end{aligned} \quad (18)$$

by using the approximations

$$\begin{aligned} A(0; m_1^2, m_2^2) & \simeq -\frac{1}{2}m_1^2 + \frac{1}{2}m_1^2 \left(1 + \frac{t}{2}\right) \ln \frac{m_1^2}{\Lambda^2} + \frac{1}{12}m_1^2 t^2 \left(1 + 3 \ln \frac{m_1^2}{\Lambda^2}\right) \\ b_0(0; m_1^2, m_2^2) & \simeq \ln \frac{m_1^2}{\Lambda^2} + \frac{t}{2} \\ A'(0; m_1^2, m_2^2) & \simeq -\frac{1}{12} \ln \frac{m_1^2}{\Lambda^2} - \frac{t}{24} \\ b'_0(0; m_1^2, m_2^2) & \simeq \frac{1}{m_1^2} \left(-\frac{1}{6} + \frac{t}{12} \right) \end{aligned} \quad (19)$$

for $|m_1^2 - m_2^2| \ll m_1^2$, $|m_1^2 - m_2^2| \ll m_2^2$ and $t = (m_2^2 - m_1^2)/m_2^2$. Λ is the usual scale mass of dimensional regularization, as introduced in the integral functionals.

6 Discussions and Conclusions

This paper is devoted to revisit calculating oblique corrections in the context of MSSM at one-loop. The theoretic motivation for this effort is due to discrepancies among the results presented in various earlier works. In contrast with those in the literature [6, 7, 8], we take the two-component spinor formalism to perform the calculation in the neutralino-chargino sector. The final results of one-loop $\Pi^{VV'}$ are examined in the large SUSY mass limit, which are further verified by the finite S , T and U parameters induced by $\Pi^{VV'}$ terms.

In comparison with those in [6] (See also [8]), we find they *exactly* coincide with our $\Pi^{VV'}$ despite the factors involved in the matrixes in (4) as the coupling coefficients, by using the relations between the B_3 and B_4 functionals in [6] and a , A and b_0 functionals in this note. In comparison with the results of S , T , U parameters in [7] (where weakly broken $SU(2)$ symmetries assumed), we find they are not agree with (16)-(18). To simplify T in (17), one can redefine the mass scale $\Lambda \rightarrow \tilde{\Lambda}$ to absorb the factor $1/3$. Consequently, T is a logarithm function in structure, as the same with that in [7]. But the coefficients of these logarithm terms do not agree.

In summary, the correct estimate of one-loop oblique corrections in the context of MSSM is obtained in terms of two-component spinor formalism. By incorporating with the bosonic contributions obtained in the previous work [3], one can apply the oblique correction as a portal to examine the MSSM in light of recent LHC data on SUSY.

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A Relevant Feynman Rules in the NC sector

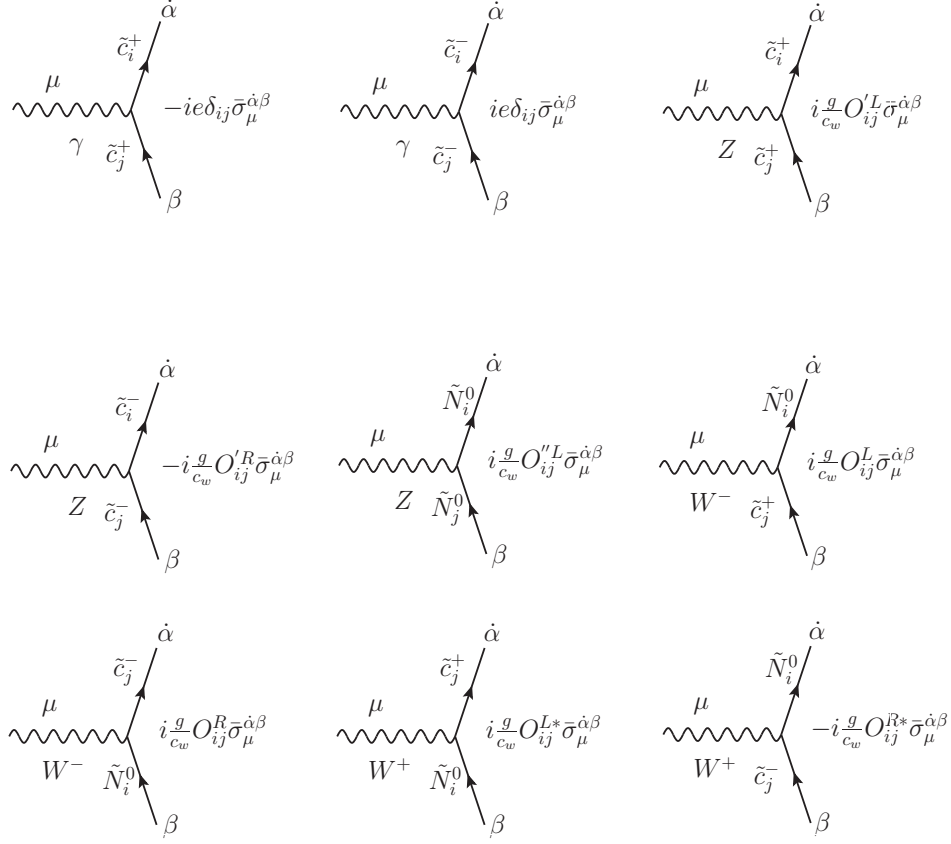


Figure 3: Relevant Feynman rules in the NC sector in two-component formalism.

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